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CASE STUDY ON ILLEGAL SAND MINING IN TAMIL NADU: ALTERNATE SOLUTION BY REPLACING NATURAL SAND BY M-SAND

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ABSTRACT

Sand mining is a practice, that is used to excerpt sand, mainly from quarry/ open pit. Sand is extracted from beaches, inland dunes, and mined from ocean beds and river beds. The excessive mining of river bed, to encounter the increasing demand for sand in construction industry, has led to the ecological imbalance in nation. Environmentalists have raised public awareness of illegal sand mining in India, especially in Tamil Nadu. Indian court has been ordered to band river sand, as sand mining affects environment and change the river direction. So, Government has put ban on mining sand from River bed. The Construction Industry started using the Manufactured Sand (M-Sand) to full degree as substitute; reduce the impacts on environment by not using the natural sand. This paper deals with the case study of Illegal sand mining in Tamil Nadu, and provides the alternate solution to use M-sand, by partial/ full replacement of natural sand by reviews.

KEYWORDS: Sand Mining, Natural Sand, M-Sand & Construction

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A Case Study

INTRODUCTION

Tamil Nadu is the second longest sandy beach front in India, stretching over 1,076 kilometers (670 miles). The rivers in Tamil Nadu have been subjected to sand mining, especially illegal sand mining continuously for the past 28 years starting from 1989, following a boom in the construction industries [1]. Palar, Vaigai, Cauvery and Thamirabarani River Basins are the major victims. Illegal sand mining is happening in these areas, in broad daylight [2]. The Tamil Nadu government estimated that approximately, between 5,500 and 6,000 truckloads, each measuring of 200 cubic feet of sand are mined in Tamil Nadu every day [1]. In January 2014, Union minister of state for Commerce and Industry worried, about the dropout of groundwater level or water table due to extraction of sand in river beds, resulted in nearly 18 lakh wells, in the southern region have gone dry and water for agriculture purposes has become scarce[3].

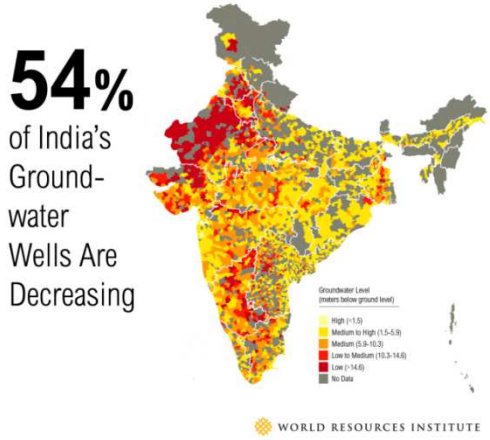

Figure 1: Groundwater Levels in India

Source: www.indiawatertool.in

Figure-1 shows the percentage decrease in the groundwater wells in India. Tamil Nadu has the world's most rapid falls in ground water at 0.34 metres/ year, in the last five years. The absolute drops in some cases were 4m in past five years. Yet, the primary crop in Tamil Nadu is rice, which requires standing water for irrigation, for the significant period of time in hot conditions [4].

Sand mining results the water table, along the river banks had gone down below 100 feet. Until a few years ago, we could get water at just 20 feet in many of the villages. It takes 500 years, for sand to form by natural process. Several quarries in Kancheepuram, Tiruvallur, Vellore and other districts of Tamil Nadu, were shut due to the variety of issues such as, bans by the district administration and local protests, over illegal mining. The dropout in ground water table and increased cost of natural sand, due to illegal sand mining leads to find a substitute for fine aggregate, without compromising the strength. In order to overcome these impacts, an alternative has to be found, in order to replace sand. The M-Sand has found to be economical alternative to the river sand. The Chief Minister of Tamil Nadu Edappadi K Palaniswani, recently suggested the construction industry, to shift to M-sand as an alternate solution to natural sand.

During the past few decades natural sand has become expensive, due to excessive cost of transport from natural sources. It is observed that, market rate of river sand is approximately Rs7000/- per brass, whereas the market rate of M-sand is approximately Rs 3000/- per brass, as the M-sand is more than 50% cheaper than Natural sand this may reduce the cost of production of concrete.

Now-a-days, many people consult Vastu Shastra, while constructing a new house. The natural sand contains ruins of human beings and animals. According to Vastu Shastra, the building material must be free from human or animal body ruins, for the human wellbeing. But, it is very difficult to remove all such traces, present in the natural sand. Henceforth, the use of good quality of manufactured/ artificial/ crushed sand is the best alternate solutions, for resolving this issue.

Environmental Impact of Sand Mining

Sand mining from river bed, impacts the environment in many ways [5]:

- Reduce water table or ground water level
- Erosion of nearby lands due to excessive sand mining

- Impurity in water.
- Abolishes the flora & fauna in surrounding areas
- The roots of the plants may not get water.
- Diminishing the number of wells,rivers or river beds.
- The connecting roads will get critically damaged and will become accidents prone

M-Sand

Artificial sand is also known by several names viz., Crushed sand, Green sand, M-sand, Pozzolana sand, Robo sand, Rock sand etc. Artificial sand is produced by rock-on-rock or rock-on-metal, Vertical Shaft Impactor (VSI) in which, the process that produced alluvial deposits is closely simulated. Reduction in particle size and achieving a good equi-dimensional shape is critical, to get anticipated properties. Washing, grading and blending have to be carried out before use, at the consumer end for the improvement of sand; but for the manufactured sand, the processes can be done at the manufacturing plant itself and controls are much better, in producing the fine aggregates [6].

General Requirements of M-Sand [6]

- Sand particles should have greater crushing strength.
- The edges of the sand particles should be shaped.
- The surface texture of the sand particles should be smooth.
- The ratio of fines below 600 microns in sand should not be < 30%.
- Silt in sand should not be > 2%.
- The permissible limit of fines for M-sand shall be < 75% microns shall not be >15%microns
- M-sand should not have any organic impurities.

REPLACEMENT METHODS OF NATURAL SAND WITH M-SAND

This section deals with the alternate solution for replacing the natural sand with M-sand by full and partial replacement methods using review studies

Full Replacement of M-Sand

Full Replacement with Manufactured Sand Concrete

An investigation on the manufactured sand is carried out by [7]with 100% replacement for fine aggregate in concrete using artificial neural networks (ANN), the influence of the physical and mineralogical properties on concrete, workability and strength. The results show that the M-sand concrete requires a higher water/cement (w/c) ratio for workability which is equal to that of natural sand concrete due to the higher angularity of M-sand particles. If the M-sand does not contain clay particles then the compensation can be done by water reducing admixtures. The compressive and flexural strength of M-sand concrete exceeds the natural sand concrete at the same water/cement ratio.

Full Replacement of Natural Sand with Nano Silica

In this investigation [8] fully replacement of M-sand by natural sand is optimized, by using Nano silica in high performance concrete. The Portland cement is partially replaced with Nano silica by 0.75% and the natural sand is fully replaced with M-sand. The results show that, the compressive, tensile and flexural strength of concrete increases with increase in the percentage of partial replacement of Nano silica.

Partial Replacement of Natural sand with M-Sand

Partial Replacement with Limestone Powder

In this investigation [9], cubes and cylinders were cast in three different grades, namely: M15, M20 and M25. The test result shows that M25 mix proportion with 0.50 water/cement ratio, gives higher compressive strengths, tensile strength and better workability. The compressive strength, tensile strength and flexural strength ranges from 18.14–36.72 N/mm^2, 10.76-18.5N/mm^2 and 12.21- 40.08 N/mm^2, for the mixes considered. These results were compared with conventional concrete. It was found that, this mixture is suitable for the structural members in buildings and other structures.

Partial Replacement with Fly Ash

An experimental investigation was carried by [10], with replacement of fly ash in the ratio of 25%, 30% and 35% respectively and concluded that, compressive strength reduces when cement is replaced by fly ash, as fly ash percentage increases compressive strength and split strength decreases.

Partial Replacement with Quarry Dust and M-Sand

In this work [11], M30 grade of concrete is designed using quarry dust and M-sand, by replacing the natural sand. Four mix proportions were cast to examine the effect of inclusion of quarry dust and M-sand, in concrete and the results were compared with the conventional concrete. The results show that, the strength of the concrete is increased in both the type of replacements.

Partial Replacement with Crushed Granite Fine

The suitability of Crushed granite fine (CGF), to replace river sand in concrete production, for use in rigid pavement was investigated in [12]. Slump, compressive and indirect tensile strength tests were performed on fresh and hardened concrete. Based on economic analysis and results of tests, river sand replaced with 20% CGF is recommended for use in the production of concrete, for use in rigid pavement. Conservation of river sand, in addition to better ways of disposing wastes from the quarry sites are some of the merits of using CGF.

Partial Replacement with Other Industrial Wastes

Eco sand, weathered crystalline rock sand and granulated blast furnace slag (GBS) as fine Aggregate Replacement: In this study, an attempt is made to use eco sand, which is a commercial by-product of cement manufacturing process, introduced by ACC Cements, weathered crystalline rock, which type of rock is abundantly available at low cost, in tropical areas and granulated blast furnace slag (GBS) is a byproduct obtained from the steel manufacturing industry, as fine aggregate replacement. M20 grade of concrete is used. A through literature review was conducted, to study and investigate the properties of these materials. The properties of materials used for replacement also

were determined. Different percentage addition of replacement materials is prepared, for conducting the test. The strength characteristic in concrete, with replacement of eco sand and weathered crystalline rock sand, was studied in detail. Since, the delay in procuring GBS, casting and testing of GBS to remains are to be done [13].

The effect of partial replacement of Robo sand, on the compressive strength of M25 grade of concrete (1:1.4:2.88), with water cement ratio 0.44 was carried out by [14]. The compressive strength of cement concrete with 20%, 40% and 60% replacement of Robo sand, gives higher strength as compared with 0% Robo sand. The overall compressive strength of the cement concrete linearly increases for 0%, 20%, 40% and 60% replacement of Robo sand, as compared with reference mix. The test results reveal that, the Robo sand provides the better replacement for natural sand.

In this study [15], one of the industrial wastes such as M-sand is used as fine aggregate in concrete. In this investigation, durability test is carried out and other tests, such as alkali aggregate reaction test, chemical attack, rapid chloride ion penetration and water permeability test are also performed. The test results revealed that, the concrete blended with 30 % natural sand and 70 % M-sand have good durability properties.

A study has been conducted by [6]; as the percentage replacement of natural sand by artificial sand increases the resulting compressive strength, is also increased. For 20% of replacement, the compressive strength is nearly the same, but for beyond 40% of replacement, the compressive strength increases considerably. For the 100 % replacement of natural sand by Artificial sand, the increase in compressive strength is nearly 16.78 %, at 28 days. This increase in strength is mainly due to the good bond characteristics of artificial sand. For 50% replacement of natural sand, the Flexure strength of the concrete is increased by 25% for M30 grade, 17% for M40 grade. The strength is reduced, when the percentage of replacement of artificial sand goes beyond 50%.

CONCLUSIONS

In this paper, the case study of Illegal sand mining in Tamil Nadu and its ill effects have been clearly discussed. The replacement of natural sand with M-sand, provides better alternate solution to resolve this issue. The use of crushed stone fine aggregate in masonry mortars and concrete is permitted in IS- 2116 and IS 383 codes. Hence, M- Sand is recommended as an alternative material, to replace natural sand. The detailed literature survey has been carried out on different grades of concrete and their strength characteristics, for the partial and fully replacement of natural sand, with M-sand.

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